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(71) Applicant: 000002369
SEIKO EPSON CORPORATION
4-1, Nishi-Shinjuku 2-chome, Shinjuku-ku, Tokyo
(72) Inventor: Sumio UTSUNOMIYA
C/O SEIKO EPSON CORPORATION
3-5, Owa 3-chome, Suwa-shi, Nagano-ken
(74) Representative: 100079108
Patent Attorney Yoshiyuki INABA (2 others)

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(54) [Title of Invention] LIQUID CRYSTAL DISPLAY DEVCIE WITH BUILT-IN BACKLIGHT AND MANUFACTURING METHOD THEREOF

(57) [Abstract]
[Problem]

A surface-emitting type light source is formed at an interface between a thin film transistor layer and a base layer, to form a liquid crystal display device with a built-in backlight.

[Means for Solving the Problem]

An active matrix including a thin film transistor, and a driver circuit thereof are formed over a first substrate with a light-transmitting property, with a separation layer interposed therebetween. After bonding a second substrate to the thin film transistor,

the thin film transistor is peeled off from the first substrate at a separation layer interface, and a surface-emitting type light source is formed over a rear surface of the thin film transistor which became exposed at that time. Subsequently, by transferring the thin film device again to a third substrate, a thin film device with a built-in surface-emitting type light source is manufactured.

[Claims]

[Claim 1]

A liquid crystal display device with a built-in backlight, wherein in a liquid crystal display device with a thin film device that includes a semiconductor circuit, a surface-emitting type light source in a thin-film form is formed at an interface between the thin film device and a substrate.

[Claim 2]

The liquid crystal display device with a built-in backlight according to Claim 1, wherein the surface-emitting type light source is an organic or inorganic electroluminescent element.

[Claim 3]

The liquid crystal display device with a built-in backlight according to Claims 1 and 2, wherein the thin film device includes:

transistors for pixel switching arranged in a matrix form;

a scan line connected to a gate of the thin film transistor;

a data line connected to a source of the thin film transistor;

a pixel electrode connected to a drain of the thin film transistor; and

a driver circuit for driving the thin film transistors for pixel switching, and a liquid crystal display element is formed over a surface of the thin film device.

[Claim 4]

A manufacturing method of a liquid crystal display device with a built-in backlight, comprising:

a first step of forming a separation layer over a first substrate;

a second step of forming a thin film device with pixels in a matrix form over the separation layer;

a third step of peeing off the thin film device from the first substrate and transferring the thin film device to a second substrate;

a fourth step of forming a surface-emitting type light source over a rear surface of the thin film device which became exposed by being transferred to the second substrate;

a fifth step of peeling off the thin film device from the second substrate and

transferring the thin film device to a third substrate; and

a sixth step of forming a liquid crystal display device over a surface of the thin film device.

[Claim 5]

A manufacturing method of a liquid crystal display device with a built-in backlight, comprising:

a first step of forming a separation layer over a first substrate;

a second step of forming a thin film device with pixels in a matrix form over the separation layer;

a third step of peeing off the thin film device from the first substrate and transferring the thin film device to a second substrate;

a fourth step of forming a surface-emitting type light source over a third substrate;

a fifth step of bonding this surface-emitting type light source and a rear surface of the thin film device;

a sixth step of peeling off the thin film device from the second substrate; and

a seventh step of forming a liquid crystal display device over a surface of the thin film device.

[Claim 6]

The methods according to Claims 4 or 6, wherein in inventions of Claims 4 or 5, the thin film device comprises:

a common electrode provided over an entire region of a light-emitting surface;

thin film transistors for pixel switching arranged in a matrix form;

a scan line connected to a gate of the thin film transistor;

a data line connected to a source of the thin film transistor;

a pixel electrode connected to a drain of the thin film transistor; and

a driver circuit for driving the thin film transistors for pixel switching.

[Claim 7]

The method according to any one of Claims 4 to 6, wherein the surface-emitting type light source is an organic or inorganic electroluminescent element, and emits light of a single color from an entire region by not patterning the pixels that are in a matrix form.

[Claim 8]

The method according to Claim 7, wherein the liquid crystal display element includes a color filter that corresponds to the pixel region.

[Claim 9]

The method according to any one of Claims 4 to 7, wherein the surface-emitting type light source is an organic or inorganic electroluminescent element, patterned for every pixel in a matrix form, and each color of RGB is aligned in predetermined order for color-separated light emission.

[Claim 10]

The method according to any one of Claims 4 to 9, wherein the third substrate is made of a flexible material.

[Claim 11]

The method according to Claim 10, wherein the third substrate is a plastic substrate.

[Claim 12]

The method according to Claims 4 to 11, wherein light that is projected from the surface-emitting type light source has a polarizing property.

[Claim 13]

A liquid crystal display device with a built-in backlight manufactured by a method according to any one of Claims 1 to 12.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The invention relates to a liquid crystal display device with a built-in backlight in which the liquid crystal display device is integrated with the backlight by transferring a thin film device onto multiple substrates, and a manufacturing method thereof.

[0002]

[Prior Art]

A liquid crystal display device with a thin film transistor (TFT), which is a thin film device, as a driver circuit source has a structure by which an image can be displayed by controlling and optical rotary power of a liquid crystal molecule (liquid crystal display element) sealed in between the substrate and an opposing substrate and controlling light-transmitting property of each pixel with a voltage that is controlled by the TFT formed over a substrate.

[0003]

This liquid crystal display device is shown in FIG. 15. As shown in FIG. 15, an active matrix substrate 220 over which an active matrix 222, a driver circuit 224 and/or the like are/is formed, and an opposing substrate 240 are attached together with a sealant (not shown in the figure) formed along an outer rim of the opposing substrate 240 with a predetermined space therebetween, and a liquid crystal 230 is sealed in this

space.

[0004]

A pixel electrode formed over an active matrix 122 and a transparent opposing electrode formed over the opposing substrate 240 face each other with the liquid crystal 230 interposed therebetween, and the liquid crystal molecules are driven by an electrical field applied between the pixel electrode and the opposing electrode. Also, an orientation film is formed over a surface of the active matrix 222 on a side that is in contact with the liquid crystal 230, as well as over a surface of the opposing substrate 240 on a side that is in contact with the liquid crystal 230, and they determine the orientation of liquid crystal molecules in a non-electrical field state.

[0005]

A liquid crystal driver portion including the active matrix substrate 220, the liquid crystal 230, and the opposing substrate 240 is interposed between two polarizing plates 210 and 250 that have different polarization directions from each other. Polarization directions of the polarizing plates 210 and 250 are aligned with orientation directions of the orientation films formed over the surfaces of the active matrix substrate 220 and the opposing substrate 240, respectively.

[0006]

Also, to make color display possible, a color filter and/or a black matrix are/is formed over the opposing substrate 240.

[0007]

In this manner, because the liquid crystal display device has a structure in which a plurality of substrates is attached together, there was a disadvantage that thickness of the display device became large. In particular, as shown in FIG. 15, a backlight 200 that is needed in a transmissive liquid crystal display device is a cause of increase in the thickness of the liquid crystal display device.

[0008]

Meanwhile, requests has been increasing for manufacturing a novel liquid crystal display device with deformability, which is a liquid crystal display device including the above-described thin film device formed over a substrate material that is lightweight and bendable (flexible) such as a plastic substrate. To realize this, it is necessary to form the thin film device at a processing temperature that is an upper temperature limit (100 to 150°C) of the plastic substrate or lower. However, reduction of processing temperature tends to lead to degradation of a thin film device characteristic, and it is difficult to manufacture a high-performance thin film device. To deal with this, a method is suggested in which a thin film device is transferred to a

plastic substrate by a technique of transferring the thin film device formed over a glass substrate (for example, see Japanese Published Patent Application No. 10-125931).

[0009]

However, even if a thin film device could be formed over a plastic substrate according to the above-described formation steps, as shown in FIG. 15, because the backlight 200 is necessary in a transmissive liquid crystal display device, it was difficult to manufacture a liquid crystal display device with deformability in its entirety.

[0010]

[Problem to be Solved by the Invention]

To solve such a problem, an object of the invention is to provide a semiconductor device that has excellent deformability, as well as a small thickness in its entirety even with a built-in backlight, and a manufacturing method thereof.

[0012]

Another object of the invention is to provide a liquid crystal display device that has excellent deformability, as well as a small thickness in its entirety by integrating a surface-emitting light source in a thin-film form with a thin film device, and a manufacturing method thereof.

[0012]

To obtain this liquid crystal display device, another object of the invention is to integrate the surface-emitting light source in a thin-film form and the thin film device over a substrate by applying a conventional transferring technique.

[0013]

[Means for Solving the Problem]

To achieve the objects, the invention is characterized by integrating a thin film device and a surface-emitting light source over a substrate using a conventional transferring technique.

[0014]

That is, a thin film device formed over a first substrate is temporarily transferred to a second substrate, and a surface-emitting light source in a thin film form is formed over a rear surface of the thin film device that is exposed at this time. Furthermore, this thin film device with a surface-emitting light source is transferred to a third substrate. By selecting a flexible and deformable substrate as this third transfer substrate, a display device with a built-in backlight that is deformable can be obtained without increasing the thickness of the entire device.

[0015]

For forming a liquid crystal display element, a typical thin film device includes

a common electrode provided over an entire region of a light-emitting surface; thin film transistors for pixel switching arranged in a matrix form; a scan line connected to a gate of the thin film transistor; a data line connected to a source of the thin film transistor; and a pixel electrode connected to a drain of the thin film transistor.

[0016]

Also, this thin film device includes a driver circuit for driving the thin film transistors for pixel switching. An acceptable thickness of the thin film device and an acceptable thickness of the entire liquid crystal display device with a built-in backlight are not particularly limited, but the thickness of the thin film device is preferably about 0.5 to 5.0mm. The surface-emitting light source is preferably an organic or inorganic electroluminescent element. One example thereof is an electroluminescent element that emits light of a single color from an entire region, in which pixels in a matrix form are not patterned. In the case that a light-emitting element that is not patterned is used as a backlight, the liquid crystal display element is provided with a color filter that corresponds to the pixel region.

[0017]

Another example of the surface-emitting light source is an organic or inorganic electroluminescent element, which is patterned for every pixel in a matrix form, and each color of RGB is aligned in predetermined order for color-separated light emission. As the organic or inorganic electroluminescent element, an electroluminescent (EL) element is most preferable.

[0018]

Because an electroluminescent element can be formed with a thickness of about several μm to several tens of μm, by forming an electroluminescent element over a rear surface of the thin film device as the surface-emitting light source and then transferring this to a bendable substrate, a semiconductor device with excellent bendability can be obtained without increasing the thickness of the device in its entirety. In addition, an organic electroluminescent element can be manufactured at a low temperature and in a simple process.

[0019]

To control transmittance/non-transmittance of light projected from the backlight by using liquid crystal, the projected light must have a polarizing property. Preferably, if the light itself projected from the backlight is given a polarizing property, a polarizing plate on a backlight side can be taken out and the thickness of the device can be reduced by that much.

[0020]

[Embodiment Mode of the Invention]

Next, an embodiment mode of the invention will be described with reference to figures. FIG. 1 is a conceptual diagram of a liquid crystal display device with a built-in backlight (hereinafter simply referred to as "liquid crystal display device") 10, and this liquid crystal display device 10 is largely sorted into a liquid crystal display portion 12, a thin film device (TFT) portion 14, a backlight portion 16, and a substrate 17.

[0021]

The liquid crystal display device 10 in FIG. 1 is a display device for a so-called monochrome image, which only performs gradation expression with the liquid crystal display portion 12. As opposed to this, FIG. 2 and FIG. 3 show the liquid crystal display device 10 for displaying a color image.

[0022]

FIG. 2 shows a display device provided with a filter portion 22 that includes a color filter 18 of each color (RGB) that is aligned according to a predetermined rule in a matrix form to correspond to each pixel formed in the TFT portion 14; and a black matrix frame 20 provided so as to surround the color filters.

[0023]

Also, FIG. 3 shows a structure in which the backlight portion 16 itself is made to emit light of each of the RGB colors by forming a bank 24 to correspond to each pixel of the TFT portion 14 and filling an ingredient of each color (RGB) of EL (electroluminescence) as an electroluminescent element that is applied as the backlight portion 16, between the banks 24.

[0024]

Basic structures of the liquid crystal display devices 10 shown in FIGS. 1 to 3 do not differ from each other; accordingly, the liquid crystal display device 10 for a color image shown in FIG. 2 is first taken as an example to describe a detailed structure.

[0025]

FIG. 4 shows a detailed structure of the liquid crystal display device 10 with a built-in backlight shown in FIG. 2.

[0026]

In a product stage of the liquid crystal display device 10, a third substrate 25 becomes a basic support layer, and layers forming the backlight portion 16, the TFT portion 14, and the liquid crystal display portion 12 are stacked. Note that during stacking of each portion over this third substrate, that is, during a production stage, it is made so that a first substrate 100 and a second substrate 180 (refer to process drawings in FIG. 5 to FIG. 13) are applied.

[0027]

The backlight portion 16 has a structure in which an EL layer 32 is interposed between this electron transporting layer 28 and a hole transporting layer 30. Also, in an upper layer of the hole transporting layer 30, an ITO layer 34 is provided. That is, by applying an electric field (voltage) between the ITO layer 34 and a base electrode layer 26, a current flows in the EL layer 32 and functions as a backlight. Note that polarization direction of emitted light form this EL layer 32 is set in a certain direction, and as a result, one polarizing plate of a pair of polarizing plates necessary for liquid crystal display can be taken out, and the surface-emitting light source can be provided directly on a rear surface of the thin film device. As a method that makes this possible, a rubbing treatment can be given. The rubbing treatment is described in detail for example in the Technical Report E1D95-106 (published in 1995) of The Institute of Electronics, Information and Communication Engineers.

[0028]

In an upper layer of the ITO layer 34, a transparent intermediary layer 36 is provided, and the TFT portion 14 as a thin film device is provided over this intermediary layer 36.

[0029]

The TFT portion 14 has a matrix form in which a TFT array 38 is provided for each pixel. The TFT array 38 includes a drain electrode 38D, a gate electrode 38G, and a source electrode 38S. Also, source/drain regions 39D and 39S correspond to the drain electrode 38D and the source electrode 38S, respectively, and an active silicon region 39G corresponds to the gate electrode 38G. A transparent pixel electrode 40 is provided for each of the TFT arrays 38 (placed to correspond to each pixel).

[0030]

Also, above the pixel electrode 40 and with a planarization film 41 in between, a pair of orientation films 44 and 46 is provided, between which a liquid crystal 42 is sealed in an intermediary space portion thereof. The liquid crystal 42 is filled in the entire pixel region once and sealed with a sealant 47 so as not to leak.

[0031]

Over an upper surface of the orientation film 46 on an upper side, an opposing electrode 48 is provided, and by applying an electrical field (voltage) between the pixel electrode 40 and the common electrode 48, orientation of the liquid 42 changes depending on the voltage applied, and a predetermined transmissivity is obtained according to light of a predetermined polarization direction that passes through the pair of orientation films 44 and 46.

[0032]

Over a top surface of the common electrode 48, with a color filter 52 therebetween, an opposing substrate 49 and a polarizing plate 50 are provided in this order. The polarizing plate 50 can only allow through light of the predetermined polarization direction, and is made to emit light with a light amount based on transmissivity that is set by the orientation of the liquid crystal 42, with respect to 100 of the amount of light emitted from the EL layer 32.

[0033]

The color filter layer. 52 includes a filter portion that aligns in an orderly manner a filter for each of the RGB colors that correspond to each pixel, and if necessary, it also includes a black matrix portion for improving color separation between the pixels by having a non-transmitting state in a non-light-emitting region (such as a region in which the TFT array 38 is placed) of each pixel.

[0034]

In the above structure, the third substrate 25 is made of a transparent synthetic resin (such as plastic) with a flexible property, and consequently, the liquid crystal display device 10 with a built-in backlight according to this embodiment mode can be provided over a base with a curved surface, and it is not necessary to maintain a flat surface

[0035]

As an example of such a base with a curved surface, a dome-shaped ceiling (hemisphere surface) can be given. By providing the liquid crystal display device 10 with a built-in backlight to such a dome-shaped ceiling, a planetarium can be made. Also, by providing the liquid crystal display device 10 with a built-in backlight over an entire surface of an inner circumference of a cylindrical room, a 360° panoramic image can be displayed.

[0036]

Because forming the TFT portion 14 using a flexible substrate as the third substrate 25 from the beginning is difficult in terms of processing temperature, precision of photolithography, and the like, previously-mentioned transferring technique is applied.

[0037]

FIG. 5 to FIG. 13 are diagrams for forming the TFT portion 14. Note that detailed manufacturing process of the TFT array 38 will be omitted because it is known.

[0038] [Step 1]

As shown in FIG. 5, a first separation layer (light-absorbing layer) 120 as a first

peeling layer is formed over the first substrate 100.

[0039]

Hereinafter, the first substrate 100 and the first separation layer 120 will be described.

(Description of the first substrate 100)

The first substrate 100 preferably a substrate with a light-transmitting property that can transmit light.

[0040]

In this case, transmissivity of light is preferably 10 or more, and more preferably 50 or more. If the transmissivity is too low, loss of the light becomes large and a larger amount of light is necessary for peeling off the first separation layer 120.

[0041]

Also, the first substrate 100 is preferably made of a highly reliable material, and in particular, it is preferably made of a material with excellent heat resistance. A reason for this is because when forming a TFT layer 140 (corresponding to the TFT portion 14 in FIG. 4) described later for example, there is a case where a processing temperature becomes high (for example, 350 to 1200°) depending on its type or formation method, and even in that case, if the first substrate 100 has excellent heat resistance, a range in setting film formation conditions such as temperature condition is widened in forming the TFT layer 140 and the like over the first substrate 100.

[0042]

Accordingly, the first substrate 100 is preferably made of a material with a strain point of T_{max} or higher, when a maximum temperature during formation of the TFT layer 140 is T_{max}. Specifically, a formation material of the first substrate 100 is preferably a material with a strain point at 350° or higher, and more preferably at 500° or higher. As such a material, a heat resistant glass such as quartz glass, Corning 7059, or Nippon Electric Glass OA-2 can be given for example.

[0043]

Also, although a thickness of the first substrate 100 is not particularly limited, usually, about 0.1 to 5.0mm is preferable, and about 0.5 to 1.5mm is more preferable. When the thickness of the first substrate 100 is too thin, this leads to reduction in strength, and when it is too thick, loss of light occurs easily in the case that transmissivity of the first substrate 100 is low. Note that in the case that light transmissivity of the first substrate 100 is high, the thickness may exceed the previously-mentioned upper limit. Note that the thickness of the first substrate 100 is

preferably even so that light can be emitted evenly.
(Description of the first separation layer 120)
The first separation layer 120 is a layer that has a property that absorbs light with which it is irradiated and causes peeling in the layer and/or at an interface (hereinafter referred to as "intralayer peeling" and "interface peeling"), and preferably is a layer with which dissipation or reduction of a bonding force between atoms or molecules of a material included in the first separation layer 120 occurs by light irradiation, that is, a layer that reaches intralayer peeling and/or interface peeling by occurrence of ablation.
[0044]
Furthermore, by light irradiation, there is a case in which a gas is released from the first separation layer 120 and a separation effect is expressed. That is, there is a case in which a constituent included in the first separation layer 120 is released as a gas, and a case in which the first separation layer 120 absorbs light and becomes a gas momentarily, a vapor thereof is released and contributes to separation. As a composition of such first separation layer 120, A to E described in the following can be given for example.
[0045]
A. amorphous silicon (a-Si)
B. various oxide ceramics such as silicon oxide or a silicide acid compound; titanium oxide or a titanic acid compound; zirconium oxide or a zirconate compound; and lanthanum oxide or a lanthanum acid compound; a dielectric material (ferroelectric), or a semiconductor
C. ceramics such as PZT, PLZT, PLLZT, and PBZT, or a dielectric material (ferroelectric)
D. nitride ceramics such as silicon nitride, aluminum nitride, and titanium nitride
E. an organic high-molecular material
F. a metal
Also, although a thickness of the first separation layer 120 differs depending on purpose of peeling and various conditions such as composition, layer structure, and formation method of the first separation layer 120, normally, about 1nm to 20μ is preferable, about 10nm to 2μm is more preferable, and about 40nm to 1μm is even more preferable. If the thickness of the first separation layer 120 is too small, evenness of film formation is lost and there is a case that peeling becomes uneven, and if the thickness is too large, it becomes necessary to increase power of light (amount of light) to secure a favorable peeling property of the first separation layer 120, and work in removing the first separation layer 120 later becomes time consuming. Note that it is preferable that the

thickness of the first separation layer 120 is even as much as possible.

[0046]

A formation method of the first separation layer 120 is not particularly limited, and is appropriately selected depending on various conditions such as film composition and film thickness. For example, various gas phase film formation methods such as CVD (including MOCVD, low-pressure CVD, and ECR-CVD), vapor deposition, molecular-beam deposition (MB), sputtering, ion plating, and PVD; various plating methods such as electroplating, immersion plating (dipping), and nonelectrolytic plating; a coating method such as Longmuir-Blodgett (LB) method, spin coating, spray coating or roll coating; various printing methods; a transferring method; a inkjet method; a powder method, and the like can be given, and tow or more of the above methods can be combined to form the first separation layer 120.

[0047]

For example, in the case that composition of the first separation layer 120 is amorphous silicon (a-Si), a film is preferably formed by CVD, particularly low-pressure CVD and plasma CVD.

[0048]

In the case of forming the first separation layer 120 using ceramics by a sol-gel method or in the case of using an organic high-molecular material, a film is preferably formed by a coating method, in particular, by spin coating.

[0049 [Step 2]

Next, as shown in FIG. 6, the TFT layer 140 is formed over the first separation layer 120.

[0050]

An enlarged cross-sectional view of a K portion (portion shown circled with a chain line in FIG. 6) of this TFT layer 140 is shown on a right side of FIG. 2. As shown in the figure, the TFT layer 140 is formed to include the TFT array (thin film transistor) 38, and this TFT array 38 is provided with source and drain regions 58 and 60 formed by introducing an n-type impurity or a p-type impurity to a polysilicon layer; a gate insulating film layer 62; a gate electrode 64; and a gate electrode line 66 and a drain electrode line 68 made of aluminum for example.

[0051]

Although in the this embodiment mode, a SiO_2 film is used as an intermediary layer provided to be in contact with the first separation layer 120, another insulating film such as Si3N4 can be used. Although a thickness of the SiO2 film (intermediary layer) is appropriately determined depending on a formation purpose thereof or a degree

of a function that can be exhibited, normally, about 10nm to 5μm is preferable, and about 40nm to 1μm is more preferable. The intermediary layer is formed for various reasons. For example, a layer that exhibits at least one function of the following can be given: a protection layer for protecting the TFT 140 physically or chemically, a insulating layer, a conductive layer, a light blocking layer for laser light, a barrier layer for migration prevention, and a reflection layer.

[0052]

Note that there is a case in which instead of forming the intermediary layer of an SiO_2 film or the like, the TFT layer 140 may be formed directed on the first separation layer 120.

[0053]

The TFT layer 140 is a layer that includes a thin film device such as a TFT as shown on a right side of FIG. 6.

[0054] [Step 3]

Next, as shown in FIG. 7, a second separation layer (for example, a hot-melt-adhesive layer, or the like) 160 as a second peeling layer is formed over the TFT layer 140. Note that, the second separation layer 160 can be made of an ablation layer in a similar manner to the first separation layer 120.

[0055]

As this second separation layer 160, electron wax that minimizes possible impurity (such as sodium and potassium) contamination of the thin film device, for example, Proof wax (product name) can be given. Also, a water-soluble adhesive is also applicable.

[0056] [Step 4]

Also, as shown in FIG. 7, the second substrate 180 is bonded over the second separation layer 160. This second substrate 180 is bonded after manufacturing the TFT layer 140, and there is no limitation on the processing temperature or the like during manufacturing of the TFT layer 140 as long as the second substrate 180 has a shape-retaining property at normal temperature. In this embodiment mode, a material with a shape-retaining property that is relatively inexpensive such as a glass substrate or a synthetic resin is used.

[0057] [Step 5]

Next, as shown in FIG. 8, light is emitted to a rear surface side of the first substrate 100.

[0058]

This light is emitted to the first separation layer 120 after passing thorough the

first substrate 100. Consequently, intralayer peeling and/or interface peeling occurs in/at the first separation layer 120, and bond strength is reduced or annihilated.

[0059]

A principle by which intralayer peeling and/or interface peeling occurs in/at the first separation layer 120 is presumed to be due to occurrence of ablation in a formation material of the fist separation layer 120; release of a gas contained in the first separation layer 120; and phase change such as melting or evaporation that occurs right after irradiation.

[0060]

Here, ablation refers to when an anchoring material (formation material of the first separation layer 120) that absorbed light with which it was irradiated is photochemically or thermally excited, a bond between atoms or molecules inside or on a surface thereof is broken and the atoms or molecules are released, and it is mainly exhibited as a phenomenon in which a phase change occurs where all or part of the formation material of the first separation layer 120 is melted, evaporated (gasified) or the like. Also, by the phase change, there is a case in which a tiny foam state occurs and bond strength is reduced.

[0061]

Whether an intralayer peeling or an interface peeling, or both of them occurring in/at the first separation layer 120 depends on various causes such as the composition of the first separation layer 120 and the like, and as one of the causes, a condition such as type, wavelength, intensity, depth of reach, or the like of a light that is irradiated can be given.

[0062]

As irradiation light, any light can be used as long as it can cause intralayer peeling and/or interface peeling in/at the first separation layer 120, and for example, X-ray, ultraviolet ray, visible light, infrared ray (heat ray), laser light, millimeter wave, microwave, electron beam, radioactive ray (α ray, β ray, γ ray), and the like can be given. Among these, in terms of easily causing peeling (ablation) of the first separation layer 120, it is preferable to use laser light, and more preferable to use an excimer laser.

[0063]

Next, as shown in FIG. 9, force is applied to the first substrate 100 to separate this surface substrate 100 off from the first separation layer 120. Although not shown in FIG. 9, after this separation, there is a case in which the first separation layer 120 sticks to the first substrate 100.

[0064] [Step 6]

Next, as shown in FIG. 10, the first separation layer 120 that is left behind is removed by a method such as cleaning, etching, ashing, or polishing, or a combination method thereof. With this, the TFT layer 140 is transferred to the second substrate 180.

[0065] [Step 7]

Next, as shown in FIG. 11, on a lower surface (exposed surface) of the TFT layer 140, a third substrate 200 over which a backlight 150 (the same as the backlight portion 16 in FIG. 16) is formed with an adhesive layer 190 interposed therebetween, is bonded. At this time, a top surface of the backlight 150 is subjected to a rubbing treatment. Alternatively, there is also a case in which the backlight 150 is formed directly below the TFT layer 140 in advance, and the backlight 150 and the third substrate 200 are attached together by providing the adhesive layer 190 therebetween. In that case, a bottom surface of the backlight 150 is subjected to a rubbing treatment.

[0066]

In the backlight portion 16 applied in this embodiment mode, EL is applied as an electroluminescent element which emits light of a single color from an entire region and does not require patterning. With this EL, since it is acceptable as long as light emission from the entire surface is performed to fit an image display region, a frame-shaped wall is formed so as to surround the region of light emission, and a fluorescent material is applied over a base surface by an inkjet method, for example.

[0067]

As preferable examples of an adhesive included in the adhesive layer 190, various curable adhesives such as a reaction curing adhesive, a thermal curing adhesive, a light curing adhesive such as an ultraviolet curing adhesive, and an anaerobic curing adhesive can be given. A composition of the adhesive may be any of an epoxy type, an acrylate type, a silicone type, and the like. Formation of such an adhesive layer 190 is done by a coating method, for example.

[0068]

In the case of using the previously-mentioned curable adhesive, for example, the curable adhesive is applied on the bottom surface of the TFT layer 140, the backlight portion 150 is bonded thereto, the curable adhesive is also applied on the backlight portion 150, and the third substrate 200 is bonded thereto; thereafter, the curable adhesive is cured by a curing method appropriate for a characteristic of the curable adhesive, and the TFT layer 140, the backlight portion 150, and the substrate 200 are bonded and fixed to each other.

[0069]

In the case that the adhesive is a light curing type, light is irradiated from outside of the third substrate 200 the preferably has a light transmitting property. By using as the adhesive a light curing adhesive such as the ultraviolet curing type which does not easily affect a thin film device layer, light irradiation may be performed form the light-transmitting second substrate 180 side, or from both the light-transmitting second substrate 180 side and the third substrate 200 side.

[0070]

The third substrate is not particularly limited, and as a result, application of a transparent substrate with flexibility is possible.

[0071] [Step 8]

Next, as shown in FIG. 12, the second separation layer 160 is heated or immersed in water, and melted. As a result, adhesive force of the second separation layer 160 is weakened, and the second substrate 180 can be separated from the TFT layer 140. Note that by removing the second separation layer 160 attached to the second substrate 180, the second substrate 180 can be reused repeatedly.

[0072] [Step 9]

Lastly, by removing the second separation layer 160 attached to a surface of the TFT layer 140, the TFT layer 140 provided with a light-emitting layer and that is transferred to the third substrate 200 can be obtained as shown in FIG. 13. Here, a surface layer relationship of the TFT layer 140 with respect this third substrate 200 is the same as an initial surface layer relationship of the TFT layer 140 with respect to the first substrate 100 as shown in FIG. 2.

[0073]

Thereafter, by forming a liquid crystal display 14 over the TFT layer 140 as well as providing the color filter layer 52, the liquid crystal display device 10 with a built-in backlight is completed.

[0074]

After going through various steps as described above, transfer of the TFT layer 140 to the third substrate 200 is completed. Thereafter, removal of the SiO_2 film adjacent to the TFT layer 140, and formation of a conductive layer such as a wiring and a desired protection film over the TFT layer 140 can also be performed.

[0075]

In the invention, because the TFT layer 140, which is the object being peeled, itself is not directly peeled but is separated at the first separation layer 120 and the second separation layer 160 and then transferred to the third substrate 200, regardless of

a characteristic, requirement, or the like of the TFT layer 140, transfer can be done easily, reliably, as well as evenly, and there is no damage to the TFT layer 140 due to a separation operation and high reliability of the TFT layer 140 can be maintained.

[0076]

Also, as an adhesive when bonding the thin film device to the second substrate, a water-soluble type can be used. On a rear surface of the thin film device that is exposed by being transferred to the second substrate, a surface-emitting backlight is attached with a non water-soluble adhesive interposed therebetween. Next, by immersing in water the device in this state, the water-soluble adhesive is dissolved in water, and the thin film device is transferred to the third substrate along with the thin film backlight.

[0077]

Also, it may be that after providing the thin film backlight to the third substrate and attaching a rear surface of the thin film device over this backlight, the thin film device is peeled from the second substrate.

(Another Embodiment Mode)

Note that in the liquid crystal display device 10 with a built-in backlight, although by providing the color filter layer 22 in an upper layer, full color image display is possible in combination with gradation expression of the liquid crystal display portion 12, there is a structure with which full color image display is possible without providing the color filter layer 22 (see FIG. 2).

[0078]

That is, as shown in FIG. 14, the EL layer 32 of the backlight portion 16 is divided by a bank 32A to correspond with a respective pixel matrix formed with the TFT portion 14, and an element for emitting light of each color of RGB (solution for forming a light-emitting layer) is injected in advance. In this case, each color of RGB is aligned vertically or horizontally side by side with each other, and by aligning them repeatedly, color display can be done with three original pixels as one pixel.

[0079]

As a method of forming the light-emitting layer for each of the RGB colors, there are the following methods. A method of forming a coloring layer by filling a solution for forming a light-emitting layer by an inkjet method and then drying it. A method of forming a coloring resist layer over a base layer and then photomasking this coloring resist layer by pixel region and subjecting it to light exposure and development, to form a coloring layer that corresponds to the pixel region. A method of applying a light-emitting layer over a base layer, and while in a state in which a resist layer is

formed thereover, this resist layer is photomasked by pixel region and subjected to light exposure and development, and then the light-emitting layer is etched from over the resist layer corresponding to the pixel region and the resist layer is peeled to form a coloring layer that corresponds to the pixel region. A method of attaching a light-emitting layer on a base layer by pixel region using a printing method, to form a coloring layer that corresponds to the pixel region.

[0080]

Also, in the case of monochrome display, because an image is formed by a gradation expression of a liquid crystal display region, a color filter such as that above becomes completely unnecessary. That is, a structure of FIG. 4 is a structure in which the color filter layer 52 is eliminated. Further, in monochrome display, as opposed the color display generating one image data with three pixels, one image data is generated with one pixel and this makes a resolution three times that of color display.

[0081]

According to this embodiment mode, with a structure in which a driver circuit made of a TFT is provided in the thin film device, it becomes unnecessary to use an external circuit such as an LSI for the driver circuit, and with this, a limitation that occurs in connecting the external circuit to the liquid crystal display device can be avoided and a selection rage of a material appropriate for the third substrate can be expanded. A circuit (active matrix and a driver circuit) that is necessary in the liquid crystal display device can be integrated into a single substrate (the third substrate) with excellent bendability, and an advantage of reduction in number of parts, or the like can be exhibited.

[0082]

[Effect of the Invention]

According to the invention described above, a semiconductor device that has excellent deformability, as well as a small thickness in its entirety even with a built-in backlight, and a manufacturing method thereof can be provided.

[0083]

Also, according to the invention, a liquid crystal display device that has excellent deformability, as well as a small thickness in its entirety by integrating a surface-emitting light source in a thin-film form with a thin film device, and a manufacturing method thereof can be provided.

[0084]

Furthermore, according to the invention, to obtain this liquid crystal display device, the surface-emitting light source in a thin-film form and the thin film device are

integrated over a substrate by applying a conventional transferring technique.

[Brief Description of Drawings]

[FIG. 1] a conceptual drawing (monochrome type) of a liquid crystal display device with a built-in backlight according to the present embodiment mode;

[FIG. 2] a conceptual drawing (full color type by filter) of a liquid crystal display device with a built-in backlight according to the present embodiment mode;

[FIG. 3] a conceptual drawing (full color type by color separation with built-in light source) of a liquid crystal display device with a built-in backlight according to the present embodiment mode;

[FIG. 4] a detailed structural diagram of a liquid crystal display device with a built-in backlight shown in FIG. 2;

[FIG. 5] a manufacturing step diagram for forming a TFT portion (step 1)

[FIG. 6] a manufacturing step diagram for forming a TFT portion (step 2);

[FIG. 7] a manufacturing step diagram for forming a TFT portion (step 3);

[FIG. 8] a manufacturing step diagram for forming a TFT portion (step 4);

[FIG. 9] a manufacturing step diagram for forming a TFT portion (step 5);

[FIG. 10] a manufacturing step diagram for forming a TFT portion (step 6);

[FIG. 11] a manufacturing step diagram for forming a TFT portion (step 7);

[FIG. 12] a manufacturing step diagram for forming a TFT portion (step 8);

[FIG. 13] a manufacturing step diagram for forming a TFT portion (step 9);

[FIG. 14] a detailed structural diagram of a liquid crystal display device with a built-in backlight shown in FIG. 3; and

[FIG. 15] an exploded perspective diagram showing a structure of a conventional liquid crystal display device with a built-in backlight.

[Explanation of Reference Numerals]

10 liquid crystal display device with a built-in backlight
12 liquid crystal display portion
14 TFT portion
16 backlight portion
22 color filter layer
25 third substrate
26 EL layer
40 transparent pixel electrode
38 TFT array

42 liquid crystal
48 opposing electrode
52 color filter layer
100 first substrate
180 second substrate
200 third substrate

[FIG. 1] 16: white light emission, 17: substrate
[FIG. 2] 16: white light emission, 17: substrate
[FIG. 3] 17: substrate
[FIG. 4] driver portion, active matrix pixel region
[FIG. 8] laser light
[FIG. 11] "rubbing treatment on this surface", "rubbing treatment on this surface"
[FIG. 12] heat
[FIG. 14] orientation film; opposing electrode (ITO); opposing substrate; sealant 47; TFT; pixel electrode; active matrix pixel region; RGB patterned light-emitting layer; electrode 26; substrate

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F term (reference)	2H091	FA07Y	FA08X	FA41Y	FA44Y	
		FC14	FC22	FC23	FD06	FD15
		GA06	GA13	LA11	LA13	
	2H092	GA59	JA24	KB23	MA31	NA27
		PA08	PA11	PA13		
	5G435	AA00	AA18	BB12	BB15	CC12
		EE12	EE26	EE33	FF05	GG12
		GG25	HH02	HH12	HH13	HH14
		HH16	KK05			